Modeling Unsteady Cavitation Effects and Dynamic Loads in Cryogenic Systems, Phase II

Completed Technology Project (2004 - 2006)

Project Introduction

There currently are no analytical or CFD tools that can reliably predict unsteady cavitation dynamics in liquid rocket turbopumps. Cavitation effects, particularly at low-flow, off-design conditions, generate large amplitude pressure fluctuations that result in performance loss, and may interact with other components to generate damaging system-wide instabilities. The innovation proposed here is the development of a numerical tool that can predict amplitudes and frequencies of dynamic pressure loads in cryogenic turbopumps. This innovation will address the inclusion of advanced unsteady cavitation models for cryogenic fluids, development of boundary conditions that include interactions with other system components, and unsteady turbulence models for off-design conditions. The resulting product, a specialized version of the multi-element unstructured CRUNCH CFD

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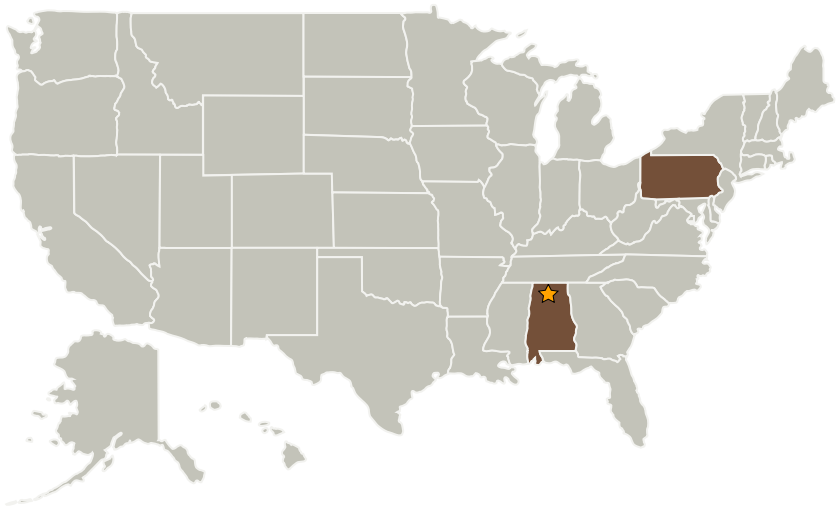
code, will be a well-validated and reliable analysis tool that can be used to predict off-design performance of liquid rocket turbopumps. Furthermore, this tool can provide unsteady loading information necessary for stress and fatigue life modeling of inducer blades. It would also be able to quantify an inducer's mean head breakdown characteristics as a function of design variables. Thus this simulation software will be used for providing design support, as well as being an analysis tool for diagnosing cavitation related anomalies in operational systems.

Primary U.S. Work Locations and Key Partners



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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Marshall Space Flight Center (MSFC)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

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Organizations Performing Work	Role	Type	Location
★Marshall Space Flight Center(MSFC)	Lead Organization	NASA Center	Huntsville, Alabama
CRAFT Tech - Combustion Research and Flow Technology	Supporting Organization	Industry	Pipersville, Pennsylvania

Primary U.S. Work Locations	
Alabama	Pennsylvania

Project Management

Program Director:
Jason L Kessler

Program Manager:
Carlos Torrez

Project Manager:
Kenneth D Evensen

Principal Investigator:
Allen P Nikora

Technology Areas

Primary:

- TX15 Flight Vehicle Systems
  - TX15.1 Aerosciences
    - TX15.1.3 Aeroelasticity